

**Listing of Claims:**

Claims 12-39, 41 and 42 are pending in this application. By this Amendment, claims 12-16, 18-23 and 40 have been cancelled. Claims 17, 24, 25, 33-35, 38 and 41 have been amended, and new claims 44-46 have been added herein.

This listing of claims will replace all prior versions, and listings, of claims in the application:

1 (WITHDRAWN): An optical element in which an angle between a  $[0\ 0\ 1]$  axis of an isometric crystal and an optical axis is less than  $10^\circ$ .

2 (WITHDRAWN): An optical element in which an angle between a  $[0\ 0\ 1]$  axis of an isometric crystal and an optical axis is  $0^\circ$ .

3 (WITHDRAWN): An optical element in which an angle between a  $[0\ 0\ 1]$  axis of an isometric crystal and an optical axis of an optical system using the optical element is less than  $10^\circ$ , and preferably  $0^\circ$ .

4 (WITHDRAWN): An optical element in which an angle between a  $[0\ 0\ 1]$  axis of an isometric crystal and an optical axis of an optical system using the optical element is  $0^\circ$ .

5 (WITHDRAWN): A manufacturing method for an optical element comprising the steps of:  
growing an isometric crystal; and  
forming the optical element from the isometric crystal that has been grown,

wherein the growing step includes the step of controlling growth so that a face orientation of the growing crystal is a  $\langle 0\ 0\ 1 \rangle$  face.

6 (WITHDRAWN): A manufacturing method for an optical element comprising the steps of:  
growing an isometric crystal; and  
forming the optical element from the isometric crystal that has been grown,  
wherein the forming step is performed by slicing the isometric crystal parallel to a  $\langle 0\ 0\ 1 \rangle$  face of the crystal.

7 (WITHDRAWN): An optical element that is manufactured by a manufacturing method according to claim 5.

8 (WITHDRAWN): An optical element according to claim 7, wherein an angle between a  $[0\ 0\ 1]$  axis of an isometric crystal and an optical axis of the optical element and/or an optical axis of an optical system using the optical element is less than  $10^\circ$ .

9 (WITHDRAWN): An optical element according to claim 8, wherein an angle between a  $[0\ 0\ 1]$  axis of an isometric crystal and an optical axis of the optical element and/or an optical axis of an optical system using the optical element is substantially  $0^\circ$

10 (WITHDRAWN): An optical element according to claim 1, wherein the isometric crystal is

fluoride.

11 (WITHDRAWN): An optical system according to claim 10, wherein the isometric crystal is any one of calcium fluoride, barium fluoride, and strontium fluoride.

12-16 (CANCELLED):

17 (CURRENTLY AMENDED): A projection optical system including more than one of the optical elements ~~according to claim 1~~ of a plurality of optical elements made of isometric crystals in which an angle between each [0 0 1] axis of the isometric crystals and an optical axis of the optical system is less than 10°, the number of which the optical elements is n, wherein the optical elements are located with one displaced from another around the optical axis so that a an [0 1 0] axis perpendicular to the [0 0 1] axis of one of the optical elements and a an [0 1 0] axis perpendicular to the [0 0 1] axis of another of the optical elements form an angle within  $90/n \pm 10^\circ$  with each other.

18-23 (CANCELLED):

24 (CURRENTLY AMENDED): An optical system including a plurality of optical elements made of isometric crystals in which an angle between a each [1 1 0] axis of ~~an isometric crystal~~ the isometric crystals and an optical axis of the optical system is less than 10°, ~~wherein one axis~~

~~of more than one of the optical elements perpendicular to the  $[1\ 1\ 0]$  axis has a relative angle different from each other wherein said plurality of optical elements include at least two optical elements of which axes perpendicular to the  $[1\ 1\ 0]$  axes are not parallel to each other.~~

25 (CURRENTLY AMENDED): An optical system ~~including a plurality of optical elements in which an angle between a  $[1\ 1\ 0]$  axis of an isometric crystal and an optical axis is substantially  $0^\circ$ , wherein one axis of more than one of the optical elements perpendicular to the  $[1\ 1\ 0]$  axis has a relative angle different from each other according to claim 24, wherein the angle between the axis of the isometric crystals and the optical axis is substantially  $0^\circ$ .~~

26 (ORIGINAL): An optical system according to claim 24, wherein the more than one of the optical elements is substitutive for an optical component derived from division of the optical elements in a plane perpendicular to the  $[1\ 1\ 0]$  axis.

27 (ORIGINAL): An optical system according to claim 24, wherein the optical system includes two of the optical elements, and a relative angle of axes of the two optical elements perpendicular to the  $[1\ 1\ 0]$  axis is  $90^\circ$ .

28 (ORIGINAL): An optical system according to claim 24, wherein the optical system includes two of the optical elements that are equal in thickness to each other, and each of the two optical elements is any one of a parallel flat plate and a lens.

29 (ORIGINAL): An optical system according to claim 24, wherein the isometric crystal is fluoride.

30 (ORIGINAL): An optical system according to claim 29, wherein the isometric crystal is any one of calcium fluoride, barium fluoride, and strontium fluoride.

31 (ORIGINAL): A projection optical system including an optical system according to claim 24.

32 (ORIGINAL): A demagnification projection optical system including an isometric crystal as an optical element, wherein more than one of the optical elements at an image side in which an angle of marginal pencils of light passing through the optical element forms an angle of  $24.6^\circ$  or greater includes an optical element according to claim 26.

33 (CURRENTLY AMENDED): A projection optical system according to claim 31, wherein an angle between a an  $[1\ 1\ 1]$  axis and an optical axis with respect to a crystal orientation of an isometric crystal is less than  $10^\circ$  in optical elements except the more than one of the optical elements in the projection optical system.

34 (CURRENTLY AMENDED): A projection optical system according to claim 31, wherein an angle between a an  $[0\ 0\ 1]$  axis and an optical axis with respect to a crystal orientation of an

isometric crystal is less than  $10^\circ$  in optical elements except the more than one of the optical elements in the projection optical system.

35 (CURRENTLY AMENDED): A projection optical system according to claim 31, wherein an angle between any one of a an  $[1\ 1\ 1]$  axis and a an  $[0\ 0\ 1]$  axis of an isometric crystal, and an optical axis is less than  $10^\circ$  in optical elements except the more than one of the optical elements in the projection optical system.

36 (ORIGINAL): A projection optical system according to claim 34 including more than one of the optical elements according to claim 24, forming a first set of optical elements, wherein a second set of optical elements within the first set of optical elements have the  $[0\ 0\ 1]$  axis substantially parallel with each other;

wherein the rest of the first set of optical elements, forming a third set of optical elements, have the  $[0\ 0\ 1]$  axis substantially parallel with each other and perpendicular to the  $[0\ 0\ 1]$  axis of the second set of optical elements; and

wherein a difference between a total thickness (element thickness on axis) of the second set of optical elements and a total thickness of the third set of optical elements is less than 10mm.

37 (ORIGINAL): A projection optical system according to claim 33, wherein a relative angle of axes perpendicular to the optical axis of the optical elements except the more than one of the

optical elements in the projection optical system is changed to reduce intrinsic birefringence.

38 (CURRENTLY AMENDED): An optical system according to claim ~~12~~ 24 that uses a light source of which the wavelength is 200nm or shorter.

39 (ORIGINAL): A projection optical system according to claim 38, wherein the light source is any one of an ArF excimer laser and an F<sub>2</sub> excimer laser.

40 (CANCELLED):

41 (CURRENTLY AMENDED): An optical system according to any one of claims ~~1 through~~ 39 17 or 24-39, wherein the optical element is one of a lens, a diffraction grating, a parallel flat plate, an optical film, and a combination thereof.

42 (ORIGINAL): An exposure apparatus that uses ultraviolet radiation, deep ultraviolet radiation, or vacuum ultraviolet radiation as exposure light, which is projected onto an object to be processed through the optical system according to claim 41 to expose the object to be processed.

43 (WITHDRAWN): A device manufacturing method comprising the steps of:  
projecting the light for exposure onto the object to be processed using the

exposure apparatus according to claim 42; and

performing a predetermined process against the object to be processed to which the light has been projected and exposed.

44 (NEW): A projection optical system for projecting a pattern of a mask, said projection optical system comprising a plurality of optical elements made of isometric crystals in which an angle between each  $[0\ 0\ 1]$  axis of the isometric crystals and an optical axis of the projection optical system is less than  $10^\circ$ ,

wherein the pattern on the mask includes a repetitive pattern and a repetitive direction of the repetitive pattern differs from directions of  $[1\ 0\ 0]$  and  $[0\ 1\ 0]$  axes that are perpendicular to the  $[0\ 0\ 1]$  axis of the isometric crystals.

45 (NEW): A projection optical system for projecting a pattern on a mask, said projection optical system comprising a plurality of optical elements made of isometric crystals in which an angle between each  $[0\ 0\ 1]$  axis of the isometric crystals and an optical axis of the projection optical system is less than  $10^\circ$ ,

wherein the pattern on the mask includes a repetitive pattern and a repetitive direction of the repetitive pattern forms one of angles of  $0^\circ$ ,  $45^\circ$ , and  $90^\circ$  with respect to a primary direction on a plane that includes the mask, and

wherein directions of  $[1\ 0\ 0]$  and  $[0\ 1\ 0]$  axes that are perpendicular to the  $[0\ 0\ 1]$  axis of the isometric crystal differ from the primary direction.



PATENT

Application Serial No. 09/934,947  
Amendment dated October 8, 2003  
Reply to Office Action of May 7, 2003  
Docket No. 1232-4756

46 (NEW): An optical system according to any one of claims 44 or 45, wherein the optical element is one of a lens, a diffraction grating, a parallel flat plate, an optical film, and a combination thereof.